Measurement of double differential cross sections of fragment-production by tens of MeV particles

Masayuki Hagiwara[1], Toshiya Sanami[2], Mamoru Baba[1], Takuji Oishi[1], Masashi Takada[3], Hiroshi Nakashima[4], Susumu Tanaka[4]

[1] *Cyclotron and Radioisotope Center, Tohoku University*
[2] *High Energy Accelerator Research Organization (KEK)*
[3] *National Institute of Radiological Sciences*
[4] *Japan Atomic Energy Research Institute*

Fragments which are secondary particles heavier than α-particle, cause a large local ionization. Therefore, the energy and angular doubly differential cross-section data (DDX) for fragments production are important for dosimetry and evaluation of radiation effects in devices or instruments, such as single event upset (SEU) by cosmic rays. Up to now, however, experimental data of the fragment production are very scarce due to experimental difficulties of the detection. Thus, almost all past experimental data were obtained by the activation method that did not provide energy and angle information. Furthermore, theoretical calculation treating fragment production is very few. Therefore, it is important to accumulate reliable experimental DDX data for fragment production.

For fragment detection, we adopted 1) a Bragg curve spectrometer (BCS) providing various information with a single counter and 2) an energy-time of fight (E-TOF) method having the capability of mass identification in almost whole energy region for a charged particle beam.

For 1), the present BCS was designed with special care to apply not only to a charged particle beam but also a neutron beam, and resulted in success to obtain light fragments by proton and neutron induced reactions. In particular, BCS proved very promising for fragments detection in neutron-induced reaction, while there are still some problems that should be solved.

For 2), we have fabricated a chamber for measurements and starting measurements. For a start detector of TOF, we will employ a MCP (multi-channel plate) coupled with a thin Al film having good time resolution and low energy loss for fragments. For a stop detector (E detector), MCP and SSD which has good energy resolution will be adopted. The scattering chamber was designed to enable simultaneous measurements of BCS and E-TOF. The combination of these methods proved very powerful for the measurement of fragments induced by charged particles.

Email: hagi@cyric.tohoku.ac.jp